APD Technical Paper 11

Basin Morphometry Data & Data Base

Province of British Columbia
Ministry of Environment

ISSN 0228-8567

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ASSESSMENT AND PLANNING DIVISION

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BASIN MORPHOMETRY DATA AND DATA BASE

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AQUATIC STUDIES BRANCH

Victoria, B.C.
June 1982

Canadian Cataloguing in Publication Data

Chamberlin, T. W. (Thomas Wilson), 1942-
Basin morphometry data and data base

(APD technical paper, ISSN 0228-8567 ; 11)

Bibliography: p.
ISBN 0-7718-8312-9

1. Watersheds - British Columbia - Data processing. I. British Columbia. Ministry of Environment. Assessment and Planning Division. II. Title. III. Series.

GB568.15.C52 551.4'028'5 C82-092221-8

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First Printing 1982.

Design & Layout
TERRESTRIAL STUDIES BRANCH

Introduction

Morphometric data provides information about the size, shape and length of various watershed elements which are important to physical and biological processes. Watershed area, for example, is closely related to runoff amount, while the shape and elevations of a basin influence peak flow timing. Channel slopes, along with the volume of runoff, characterize the ability of a stream to transport material. Biotic communities are likewise distributed along the length of streams in response, among other things, to volumes of runoff, sediment transport and other processes influenced by morphometric variables.

Morphometric data must be used with caution, however, since a number of factors may confound their application. Most morphometric data are extracted from topographic maps. Hence consistency of scale and mapping standard between map sheets is of paramount importance. Elevation data extracted from topographic maps will only be as accurate as the location and interval of the mapped contour lines, while stream lengths (usually a blue solid or dashed line) represent an interpretation of the channel expression which may or may not reflect the actual channel, and which will quite likely vary between adjacent watersheds if they are of different complexity.

The random basis of most geomorphologic processes suggests that morphometric analyses are most appropriate for stratifying types of basins within or between regions as opposed to answering specific questions about particular watersheds. The interpretation of morphometric data will always be enhanced by comparable information about geology, climate, hydrology and biology, which together will shed some light on the "physics" of the complex interactions of all biophysical processes.

For those not familiar with morphometric analysis and its applications, publications such as Schumm (1955, 1977), Melton 1958), Morisawa (1971), Gardiner and Park (1978) or Strahler (1964) may be consulted. Strahler, in particular, offers a comprehensive review.

It should be clear that the wholesale accummulation of morphometric data will not usually be cost-effective without a clear idea of its intended objective, a choice of appropriate maps and scales and a well organized data capture process.

This publication describes a data card and data base which has been designed to facilitate the systematic compilation of some morphometric data currently being used for the purpose of watershed stratification. Other morphometric data can also be extracted during the data capture process, and users are invited to contact the Standards and Data Unit, Aquatic Studies Branch (387-1987) for more information.

Appendix A contains detailed data entry instructions, while Appendix B defines all terms.

Data Base Structure

The morphometric data set is identified with a particular watershed or partial watershed above any given point on a stream. This point on the stream is described by its distance upstream from the outlet or confluence. Hence multiple morphometric data sets may be compiled within the same basin, each applicable to different partial basins of interest, such as above successive points of water diversion.

Use of the morphometric data card should be preceded by plotting the watershed boundary on an appropriate topographic

base, beginning at the watershed's mouth and proceeding uphill. Basins are assigned watershed code numbers by the Standards and Data Unit, Aquatic Studies Branch (387-1983). Elevations are interpreted by inspection of contour line distribution, bearing in mind their inherent accuracy.

Channel lengths (mapped or extended) are measured up the mainstem to the appropriate endpoint. (see Appendix B). Using standard digitizing equipment, a digitizing accuracy of 95-98% may be expected for small to moderate sized streams. Some cumulative error will occur for long streams, for example those extending over several map sheets. For wide streams (i.e. with a mapped width), the stream line should be drawn up the inferred thalweg (deepest part of the channel).

Areas, perimeter and channel length data should be digitized using a digitizing table with an accuracy of $\pm$ 0.25 mm. or equivalent. Map wheels, in particular, are not advised since they consistently underestimate total length due to the difficulty of following stream meanders.

Aspect and stream order are calculated by inspection using standard methods (Strahler, 1964). Aspect is entered to the nearest degree, but carries a subjective variability in the neighborhood of $\pm 5^{o}$. It is meaningless, and should not be entered, for basins with significantly non-linear shapes.

Detailed Morphometric Data

The reverse side of the data card permits the compilation of areas and elevation associated with successive distances up the mainstem of a given basin. Only the distance upstream, elevation and associated area above the contour line are entered. Note that these <u>contour</u> areas are not equivalent to the watershed area on

the front of card, but instead are the area of the entire basin above the specified elevation (see Figure 2).

When detailed data are compiled, the general information on the front of the card should also always be completed so that the details can be placed in context.

Detailed morphometric data are used to generate channel profiles (distance-elevation) and hypsometric curves (area-elevation).

References Cited

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Appendix A Morphometry Data Entry Instructions

The following data entry instructions follow the format of "Data Entry Proceedures", APD Tech. Paper No. 3 for the British Columbia Aquatic Biophysical inventory system. Figure 1 references the field parameters to the data card. Note that the reverse of the card repeats field numbers 1, 2, 3, 17 and 18 for successive elevation steps within the same basin, and adds one new parameter, the contour area.

See Appendix B for field name definitions.

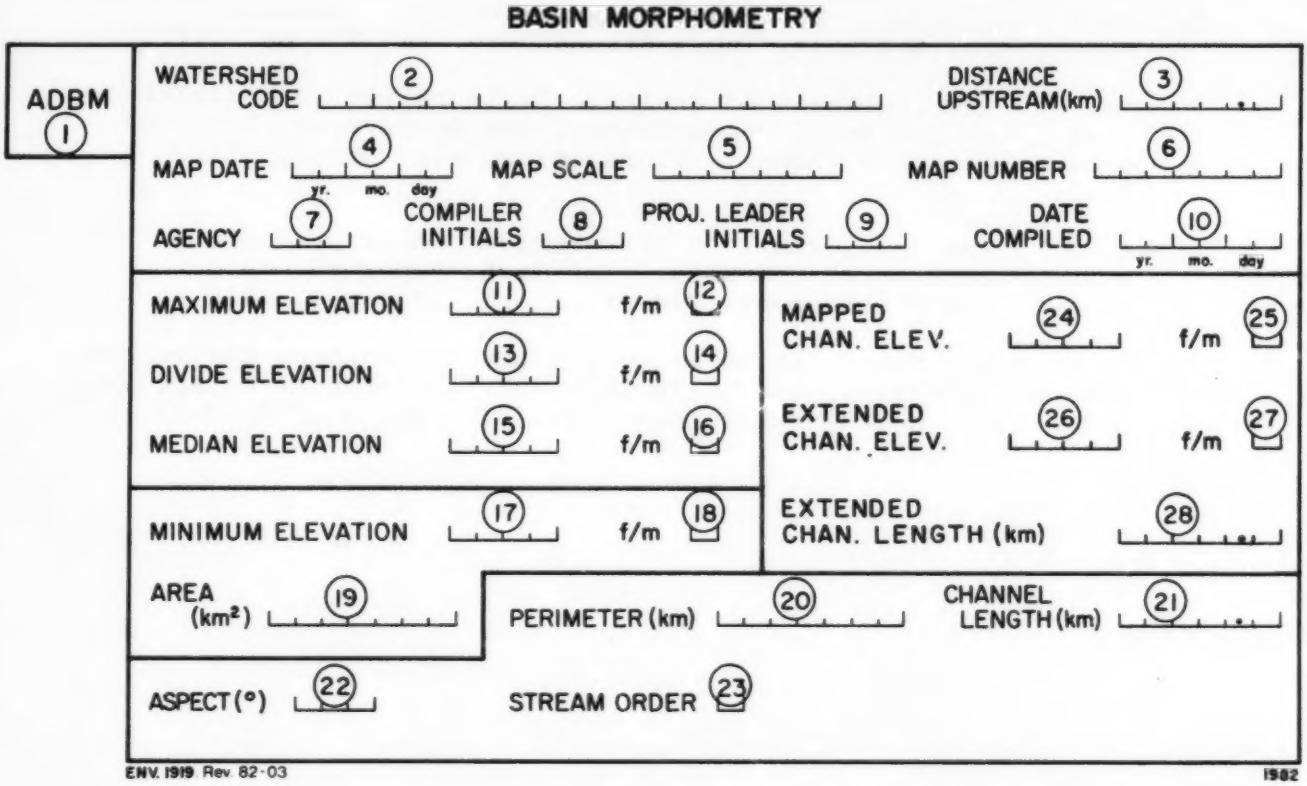

Figure 1. Card reference numbers: Morphometry Data. Reference number 29 (contour area) is on the reverse side.

MORPHOMETRY DATA CARDS

Card Ref. No.	Field Name	Field Limits	Field Width	Field Type	Field and Data Entry Instructions
1	ADBM		4	A	Not field entered.
2	Watershed		21	N	Mandatory. Left justify. As given in dictionary. All significant digits should be recorded plus one extra zero.
3	Distance upstream	0.0-9999.9	6	N	Mandatory. Right justified. Code to nearest 0.1 Km.
4	Map Date (Year, Month, Day)		6	N	Two digits for each of year, month and day. If not known, record as zero. Year mandatory.
5	Map Scale		7	N	Natural scale (e.g. 1:15284) NOT chains or feet to the inch. Right justify. Do not record the "1:".
6	Map Number		7	A/N	One map sheet number. Left justify. DO NOT use slashes (i.e. "/"). If Aquatic Bio-physical base, enter "A" in right hand (last) space.
7	Agency		3	A/N	Use defined Agency/Reference code. Left justify.
8	Compiler Initials		3	A	Left justify.
9	Proj. Leader Initials		3	A	Left justify.
10	Date Compiled		6	N	Mandatory. Year, Month, Day.
11	Maximum Elev.	1-9999	4	N	Right justified. DO NOT enter decimal values
12	f/m		1	A	If value exists for Max. Elevation, then f or m must be entered.
13	Divide Elev.	1-9999	4	N	Right justified. DO NOT enter decimals.
14	f/m		1	A	If value exists for Divide Elev., then f or m must be entered.
15	Median Elev.	1-9999	4	N	Right justified. DO NOT enter decimal values
16	f/m		1	A	If value exists for Median elev., then f or m must be entered.

MORPHOMETRY DATA CARDS

Card Ref. No.	Field Name	Field Limits	Field Width	Field Type	Field and Data Entry Insturctions
17	Minimum Elev.	0-9999	4	N	Right justified. DO NOT enter decimal values.
18	f/m		1	A	If value exists for Minimum Elev., then f or m must be entered.
19	Area	0.1-99.9 100-9999999	7	N	Right justified. Decimal values allowed to 99.9, then use integers. DO NOT enter units.
20	Perimeter	0.1-99.9 100-9999999	7	N	Right justified. Decimal values allowed to 99.9, then use integers. DO NOT enter units.
21	Channel Length	0.1-9999.9	6	N	Right justified. Code to nearest 0.1 km.
22	Aspect	0-360	3	N	Right justified. May be blank
23	Stream Order	1-9	1	N	Integer only
24	Mapped Channel Elevation	0-9999	4	N	Right justified. DO NOT enter decimal values.
25	f/m		1	A	If value exists for Mapped Channel Elevation, then f or m must be entered.
26	Extended Channel Elevation	0-9999	4	N	Right justified. DO NOT enter decimals.
27	f/m		1	A	If value exists for Extended Channel Elevation., f or m must be entered.
28	Extended Channel Length	0.1-0000.9	6	N	Right justified. Code to nearest 0.1 km.
29	Contour Area	0.1-99.9 100-9999999	7	N	Right justified. Decimal values allowed to 99.9, then use integers. DO NOT enter units.

Appendix B Morphometric Data Definitions

Morphometric data are intended to be complementary to parameter fields used in the standard Aquatic Biophysical Inventory. Hence, terms which overlap are defined exactly as in "Aquatic Survey Terminology", APD Technical Paper 2, 1980 (T. Chamberlin, Editor).

Other definitions are taken from standard references (see References Cited) as far as possible. In all cases where Aquatic Biophysical maps have been published, the watershed boundary will be as delineated on that base.

Figure 2 illustrates some basic concepts.

A: Watershed mouth
Distance upstream = 0.0 km
Minimum elevation = 0 f

B: Partial watershed mouth
Distance upstream = 1.5 km
Minimum elevation = 160 f

C: Mapped channel limit
Mapped channel elevation = 350 f

D: Maximum elevation = 1450 f
Watersheds A and B)

Contour area above 500 f in Watershed A

Contour area above 500 f in Watershed B

Order (Watershed A) = 4
Order (Watershed B) = 3
Aspect (Watershed A)= 220°
Aspect (Watershed B)= 205°

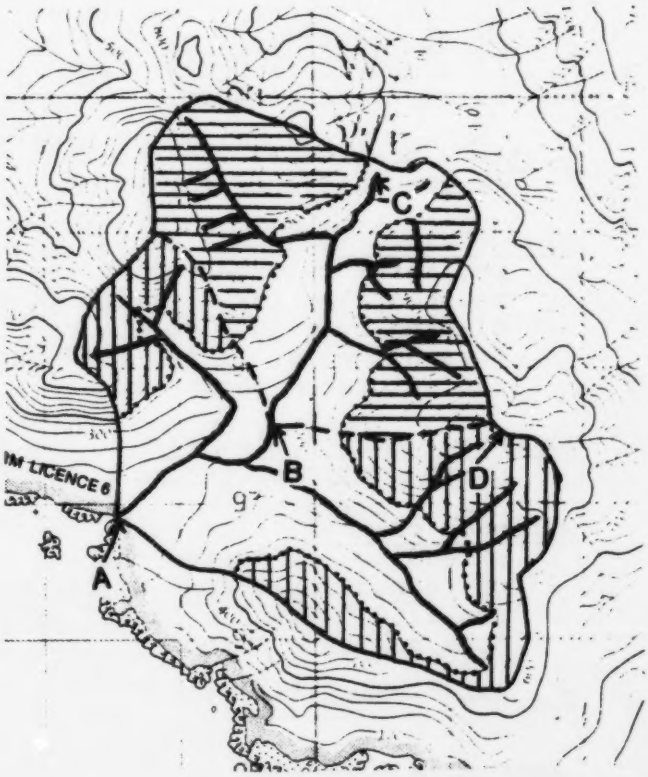

Figure 2. Examples of morphometric variables in a small (fourth order) watershed.

Agency: The code assigned to the agency or group doing the morphometric analysis. Consult Standards and Data Unit, Aquatic Studies Branch for designated code.

Area: The area of the watershed as delineated on the base map.

Aspect: The angular clockwise distance from true north in degrees of the general direction of flow of the mainstem channel. Only channels with a general linear trend should be assigned an aspect.

Channel length: The length of the mapped channel line.

Compiler initials: The initials of the person compiling the data from the map to the data card.

Contour area: The area of a watershed above a specified elevation.

Date compiled: The Year Month Day that the compilation is completed. If daily resolution is not possible, enter only Month and/or Year as appropriate, plus zeros. In the absence of a compilation date, specify the start time of the morphometric data project.

Distance upstream: The distance upstream from the stream outlet of the watershed for which the data are being compiled.

Divide elevation: The elevation of the point on the watershed perimeter intersected by the extended channel, if it reaches that far. Divide elevation points are usually flanked by higher points on both sides. A divide elevation does not exist if the extended channel line does not reach the watershed perimeter.

Extended channel elevation: The elevation of the highest point on the extended channel (see Extended Channel).

Extended channel: The total length of channel as inferred by extending the mapped channel line up-slope to the limit of recognizable contour crenulations. The line will terminate (on 1:50 000 scale bases) at the first contour line which does not have a recognizable crenulation.

Extended channel length: The length of the extended channel line.

f/m: feet/meters - elevation units

Map base: The map base for morphometric data analysis will normally be the published 1:50 000 NTS series. Where a published Aquatic Biophysical map exists on which drainage channel locations have been updated, it may be used and is indicated by an "A" following the map number. Care should be taken in basin analysis to use data derived from comparable bases.

Map date: The base map's date of publication. The most recent revision of the topographic or drainage properties should be indicated, if applicable. Revisions of cultural information do not constitute revisions of the base map for morphometric purposes. Format is Year Month Day, if available.

Map number: The NTS mapsheet designations (e.g. 93P3). Aquatic Biophysical base maps are indicated by an 'A' in the right-hand space of the map number data field.

Mapped channel elevation: The elevation of the highest point on the mapped channel line (see map base).

Mapped channel line: The dashed or solid blue line on the published N.T.S. topographic map, or the equivalent mapped stream line on the Aquatic Biophysical Map if that base is used for morphometric analysis.

Map scale: The absolute (natural) scale (i.e. 1:50000) of the base map. Only the number following the colon (i.e. 50000) is entered.

Maximum elevation: The highest elevation on the perimeter of the watershed boundary.

Median elevation: The elevation which divides the basin area into equal halves.

Minimum elevation: The elevation of the outlet point of the watershed, or, in the case of watersheds with internal drainage, the lowest point in the basin.

Perimeter: The length of the watershed boundary line.

Proj. leader initials: The initials of the person responsible for the morphometric analysis project for which the data are being compiled.

Stream order: The Strahler stream order (see Chow, 1964 or any geomorphology text) of the lowest segment of the mapped channel). A first order stream channel has no tributaries. A second order channel has only first order tributaries, etc.

Watershed code: The British Columbia Aquatic Data Base watershed code. See Shera and Grant, 1980, and "Aquatic Survey Terminology".

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